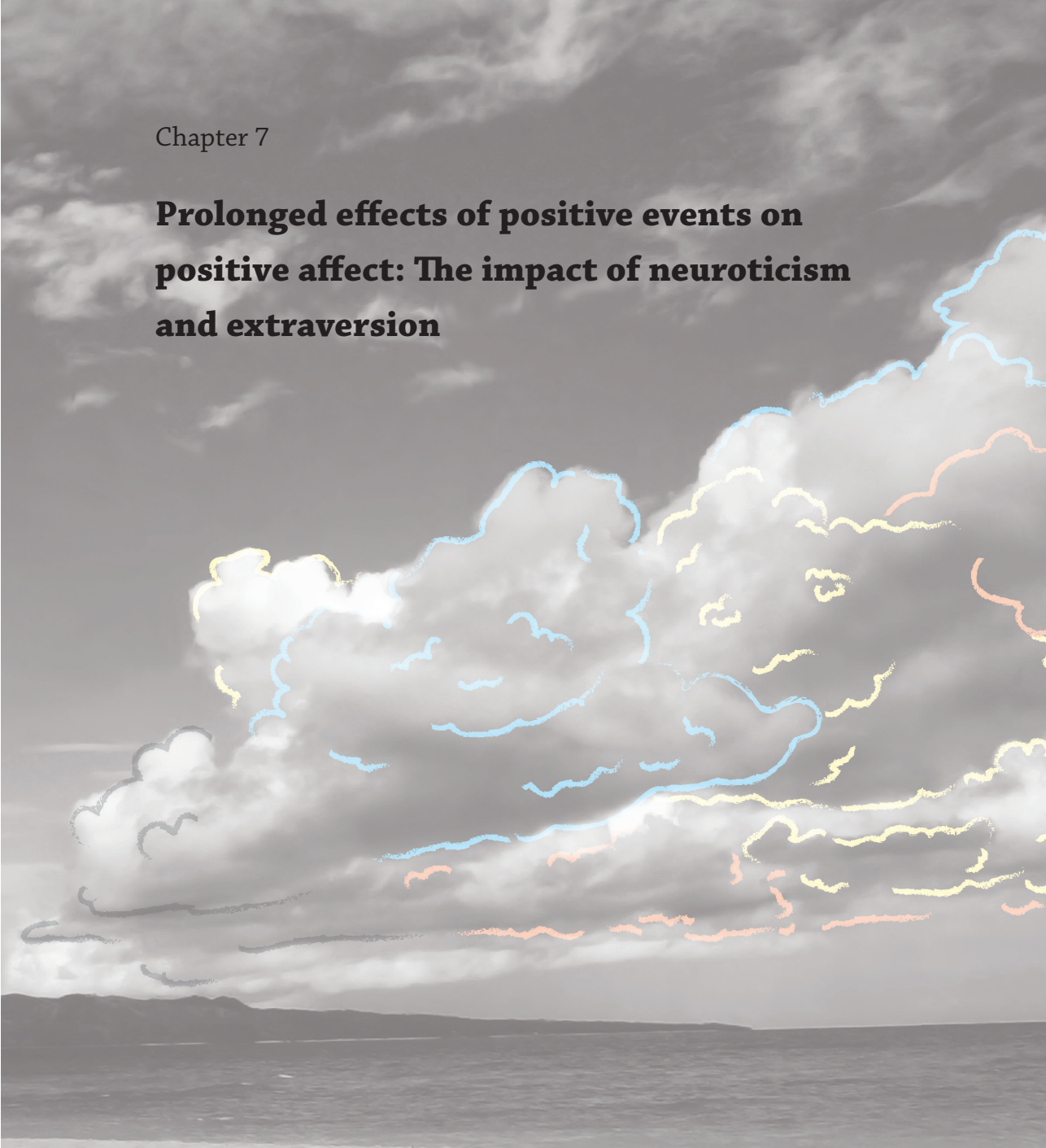
Every dark cloud has a colored lining

Bennik, Elise



Chapter 7

Prolonged effects of positive events on positive affect: The impact of neuroticism and extraversion

Based on:

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Abstract

Until now, studies have mainly focused on personality differences in effects of positive events on positive affect in the short run. Examining personality differences in prolonged effects (i.e. effects over a couple of hours) appears to be more relevant, because individuals who are capable of maintaining PA in response to positive events might be happier and more resilient to affective symptoms. The aim of this study is to directly examine effects of neuroticism and extraversion on prolonged effects of positive events on PA in an ecologically valid way without relying on retrospective methods. We used two independent Experience Sampling studies of female adolescents (N = 141, M_{age} = 14.12) and young female adults (N = 70, M_{age} = 20.96) with measurements of positive events and PA several times a day during six to fourteen days. We found a negative relation between neuroticism and mean PA, and a positive relation between extraversion and mean PA. Prolonged effects of positive events on PA were not consistently influenced by neuroticism or extraversion. Neuroticism and extraversion are related to PA levels, but not with PA reactivity with positive events in daily life.

Introduction

After a long period of research mainly focusing on negative affect and neglecting positive affect (PA), there has been a rapidly growing interest in PA during the last twenty years (Tugade, Shiota, & Kirby, 2014). This is not surprising, since PA has been associated with unique beneficial effects on social, cognitive, behavioral and health domains (e.g. Chida & Steptoe, 2008; Fredrickson, 1998; Howell, Kern, & Lyubomirsky, 2007). Moreover, PA occurs more frequently and for longer periods of time than negative affect (Verduyn & Brans, 2012). Recent studies investigating momentary PA patterns in daily life have revealed important findings. For example, it has been found that the extent to which PA persists from moment to moment predicts the future course of depressive symptoms (Höhn et al., 2013).

Momentary PA is predominantly influenced by environmental factors (Menne-Lothmann et al., 2012), including positive events which often boost PA (e.g. Zautra et al., 2005). The impact of a positive event is temporary; the rise in PA after a positive event is followed by a return to baseline PA levels sooner or later (e.g. Kuppens et al., 2010). Until now, studies have mainly focused on between-person differences in the extent to which positive events influence PA in the *short* run (i.e. initial effects). This is unfortunate, since studies examining between-person differences in *prolonged* effects (i.e. effects over a couple of hours) seem particularly relevant, because intuitively, it is expected that the longer the effect of positive events lasts the better it is. This has been supported by previous research demonstrating that the inability to sustain PA in response to positive events was a better predictor for depressive symptoms than the initial response to positive events (McMakin et al., 2009), and that strategies that dampen or savor PA predicted depressive symptoms (Raes, Smets, Nelis, & Schoofs, 2012) and happiness (Jose, Lim, & Bryant, 2012), respectively.

It seems especially important for positive events to exert prolonged effects on PA for individuals with low average levels of PA, because otherwise PA will return quickly to its typical low level. High neuroticism and low extraversion are personality characteristics that have been associated with low average levels of PA in daily life (e.g. Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Longua et al., 2009; Zautra et al., 2005). Therefore, being able to sustain PA after positive events may be particularly important for individuals high in neuroticism and low in extraversion. Studies suggest, however, that individuals high in neuroticism or low in extraversion are less able to

sustain heightened PA after positive events, because these individuals reported the use emotion regulation strategies that dampen PA more often and strategies that savor PA less often (Bryant, 2003; Gentzler et al., 2014; Gresham & Gullone, 2012; Livingstone & Srivastava, 2012; Wood et al., 2003; Yoon et al., 2013).

Hemenover and colleagues (2003) were among the few who directly examined the influence of neuroticism and extraversion on how long PA is sustained over time in response to events. More than 200 participants reported their affect two times after watching, amongst others, videos that induced PA. Overall, individuals high in neuroticism showed a rapid decline in PA, while individuals high in extraversion showed a slow decline in PA, but findings were unstable across their three studies. In addition, the study was limited in that PA was only measured over a short time-span (i.e. 20 minutes) in an artificial test situation.

Verduyn and colleagues (2009; 2012) adopted a more ecologically valid approach to study how long PA is sustained over time in response to events. In their studies, participants retrospectively reported the frequency, intensity, and duration of PA evoked by specific internal or external events at the end of the day for a period of one week. In the study of 2009, extraversion did not relate to the duration of PA, while neuroticism did relate to the duration of PA in one out of two studies, but in an unexpected direction (i.e. individuals higher in neuroticism experienced a longer duration of PA). In the 2012 study, only extraversion correlated with the duration of PA (i.e. individuals high in extraversion experienced a longer duration of PA). Thus, neuroticism and extraversion have been sporadically found to be differentially associated with the duration of PA, but findings are not consistent across studies. The study of 2012 addressed some limitations of the study of 2009 (i.e. small sample size, closed response format of affect duration, lack of PA items that reflect affect low in arousal such as 'satisfied'), but was still limited in that participants reported the duration of affect retrospectively (at the end of the day), which may have caused memory biases and influenced the results. To thoroughly investigate the influence of neuroticism and extraversion on prolonged effects of positive events on PA, Experience Sampling Measurements (ESM) are needed that assess events and affect multiple times a day.

Unfortunately, the influence of neuroticism and extraversion on PA reactivity to positive events have been mainly studied in artificial situations (e.g. Gross et al., 1998; Larsen & Ketelaar, 1991; Lucas & Baird, 2004; Rusting & Larsen, 1997) and only a

few times in daily life (David et al., 1997; Jacobs et al., 2011; Zautra et al., 2005). From these daily life studies, only one study (Jacobs et al., 2011) assessed events and affect multiple times a day, but this study examined short-term effects rather than prolonged effects of positive events on PA. Hence, it is still unknown whether neuroticism and extraversion moderate prolonged effects of positive events on PA.

The previously mentioned studies were based on adult populations. It is highly relevant to also investigate effects of positive events on PA in adolescence and young adulthood for several reasons. First, neural systems underlying PA undergo extensive development during these periods (e.g. Davey, Yücel, & Allen, 2008; Forbes & Dahl, 2012; Galvan, 2010; May et al., 2004). Second, PA has a vital function in establishing and maintaining social relationships (e.g. Watson, Clark, McIntyre, & Hamaker, 1992), which are particularly important for adolescents and young adults (e.g. Forbes & Dahl, 2005; Greenberg, Siegel, & Leitch, 1983; La Greca & Harrison, 2005). Third, it has been shown that the incidence of affective disorders increases in adolescence and young adulthood (Kessler et al., 2001), and that young females are particularly prone to affective disorders (Angold & Worthman, 1993; Hankin et al., 1998; Wade et al., 2002). There has been only one daily life study in adolescents that investigated the role of negative emotionality and surgency (i.e. concepts related to neuroticism and extraversion, respectively) in effects of positive events on PA (Gentzler et al., 2014). This study did not find that surgency or negative emotionality influenced adolescents' PA reactions. However, this study is limited in that results were based on retrospective recollection of PA and events at the end of the day.

To fill the knowledge gap in the literature, this study aimed to examine the influence of neuroticism and extraversion on prolonged effects (i.e. effects over several hours) of positive events in daily life in a direct and ecologically valid way without relying on retrospective methods. We hypothesized that neuroticism would be negatively associated whereas extraversion would be positively associated with the extent to which a person benefitted from positive events over an extended period. We investigated this hypothesis by measuring positive events and PA in early adolescent and young adult females several times a day during six to fourteen days. This study was unique in the use of two independent ESM studies, which enabled us to investigate the robustness of effects.

Methods

Participants

Study 1. Female students were recruited via posters in an electronic learning environment and educational buildings of the University of Groningen and School for Higher Professional Education in Groningen, the Netherlands. Five hundred eighty-nine female students responded with interest in participating in the Uncovering the Positive Potential of Emotional Reactivity (UPPER) study (i.e. a combined ESM-fMRI study on affect dynamics), and were sent an information letter about the study. Eventually, 268 students (45.5%) sent back the informed consent form and filled out an online screening questionnaire (www.unipark.de). The screening questionnaire contained inclusion criteria (i.e. female gender, age between 18 and 25 years, and Dutch as native language), exclusion criteria (i.e. inability to keep an electronic diary five times a day, current psychiatric disorders, and standard MRI incompatibility criteria), and the neuroticism and extraversion scale of the NEO Five Factory Inventory (NEO-FFI, Hoekstra et al., 1996). We used the 60th percentile score of the neuroticism scale (score = 31) as selection criterion for participation, and randomly selected 50 participants who scored above, and 25 who scored below this criterion. This selection procedure resulted in an approximately normal distribution of neuroticism scores. The final sample consisted of 70 students, because one participant dropped out of the study after one measurement day and four participants were excluded from statistical analyses due to poor compliance (i.e. less than 50% compliance rate, n = 1) or lack of reported positive events (i.e. less than 8 measurements in which the most important event was rated as positive, n = 3). The included participants were on average 20.96 years old (SD = 1.84). The majority of the participants attended university education (87.1%), the other participants attended higher professional education (12.9%).

Study 2. Nine hundred thirty-three adolescents of four secondary schools in the Eastern part of the Netherlands were sent an information letter about the study. Three hundred thirty-nine adolescents (36.9% of the total number of approached adolescents) and their parents provided informed consent to participate in the study of whom 36 adolescents were not able to participate due to illness or organizational problems or because they withdrew their consent. To be able to make a direct comparison with Study 1, we focused on data of the 179 female adolescents (59.1%). Our final sample consisted of 141 female adolescents; 38 participants were excluded from statistical analyses due to

poor compliance (i.e. less than 50% compliance rate, $n = 25$) or lack of reported positive events (i.e. less than 8 measurements in which the most important event was rated as positive, $n = 13$). The mean age of the participants was 14.12 years ($SD = 0.52$), and all participants were in their second year of secondary education. Of this group, 44.0% attended preparatory secondary school for university, 36.2% attended preparatory secondary school for professional education, and 19.3% attended preparatory secondary school for technical and vocational training. Detailed information about the selection of participants is reported by van Roekel et al. (2014).

Procedure

Study 1. ESM data were collected by (1) Personal Digital Assistants (PDAs) based on the PsyMate technology developed by Maastricht University (Myin-Germeys et al., 2009), or (2) smartphones via a web-based application implemented in software for routine outcome monitoring (ROQUA, www.roqua.nl). Thirty participants preferred to use a PDA (42.9%) and 40 participants the web-based application on their smartphones (57.1%).

In an individual introduction session one day before the start of the ESM period, several questionnaires were administered and information was provided about how to use the PDA or web-based application and how to interpret the ESM questions. The ESM period consisted of fourteen consecutive days with five questionnaires per day during waking hours, at fixed time points separated by 3-hour intervals. The exact time points of the measurements were adjusted to the participant's usual daily rhythm. Automated auditory signals or web-based generated text messages informed participants that a new measurement was available. To minimize memory distortion, we asked the participants to complete the measurements as soon as possible, but at maximum 30 minutes after the signal. The participants could contact the researchers for technical support when necessary, and were contacted by telephone at the end of the first week to check the functionality of the equipment and answer any questions. All participants were paid €30 with a bonus of €20 for those who completed a minimum of 63 out of 70 measurements.

Study 2. ESM data were collected by providing smartphones to the participants, on which an open-source program (http://myexperience.sourceforge.net) was installed to gather data in the daily lives of the participants. Three to eight weeks before the

start of the ESM data collection, several questionnaires were administered online during school hours. One day before the start of the ESM period, participants were individually instructed about the ESM procedure and how to use the smartphones. The ESM period consisted of six consecutive days with nine questionnaires per day during waking hours, at random time points during 90-minute intervals. Buzzing signals informed participants that a new measurement was available. Participants were instructed to complete the measurements as soon as possible after the signal. The buzzing signal was repeated after two, four and six minutes when participants did not respond. After eight minutes, participants were unable to access the measurement. When participants missed two consecutive measurements they received a text message or were contacted by telephone to encourage them to attend to their smartphones and fill out the measurements. Participants could contact the researchers by telephone for technical support. Participants were paid €20 when they completed a minimum of 30 out of 54 measurements. Detailed information about the procedure of Study 2 has been reported by van Roekel et al. (2014).

Measures

Momentary assessment of positive affect (PA). In both studies, momentary positive affect (PA) was measured by the same four affect items: cheerful, satisfied, energetic and relaxed. Participants were asked to rate the items on a scale ranging from 1 (not at all) to 7 (very). The items were averaged into a PA score, which had a Cronbach's alpha of .78 in Study 1 and a Cronbach's alpha of .77 in Study 2 (calculated across all time points and participants), indicating good internal consistency.

Momentary assessment of positive events. The participants rated the valence of the most important event that had happened since the previous beep on a 7-point scale, ranging from -3 (very unpleasant) to +3 (very pleasant). To examine the effect of positive events on PA, we recoded negative event scores into 0, resulting in a range of 0 to +3 (see Wichers et al., 2009 for a similar procedure for an activity-related measure of reward).

Neuroticism and Extraversion. In Study 1, neuroticism was measured by the neuroticism scale of the Dutch version of the Eysenck Personality Questionnaire Revisited Short Scale (EPQ-RSS, Sanderman, Arrindell, Ranchor, Eysenck, & Eysenck, 1995). In Study 2, neuroticism was assessed by the neuroticism scale of the Dutch version of the Junior Eysenck Personality Questionnaire (JEPQR-S, Scholte & De

Bruyn, 2001). The EPQ-RSS and the JEPQR-S neuroticism scales both comprise of 12 items, which can be scored on a dichotomous scale (yes or no). Cronbach's alpha of the neuroticism scale was .72 in Study 1 and .75 in Study 2.

In Study 1, extraversion was measured with the extraversion scale of the Dutch version of the NEO Personality Inventory- Revised (NEO-PI-R, Hoekstra et al., 1996). The scale contains 48 items, which are scored on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). In Study 2, extraversion was measured using the extraversion scale of the Dutch version of the JEPQR-S (Scholte & De Bruyn, 2001). This scale comprises 12 items, which can be scored on a dichotomous scale (yes or no). Cronbach's alpha of the extraversion scale was .91 in Study 1 and .78 in Study 2.

Selection of time points

Study 1 and Study 2 differed in the average time between two consecutive measurements. In Study 1, the time points were fixed with 3-hour intervals, while in Study 2 the time points were random with 90-minute intervals on average. Due to missing data, the time between two consecutive measurements was occasionally more than four hours in both studies. To make the time intervals between two consecutive measurements more comparable between studies, we selected only measurements at which a minimum of 30 minutes and a maximum of 240 minutes had elapsed since the previous measurement.

Statistical analyses

First, we calculated mean scores of PA and the positive event score by averaging the PA and positive event scores across all time points for each participant. Second, we calculated descriptive statistics and Pearson product moment correlations between mean PA, mean positive events, neuroticism and extraversion. Third, we performed multi-level regression analyses with the momentary repeated measurements (level 1) nested within participants (level 2) to examine whether neuroticism and extraversion moderated the prolonged effect of positive events at *t-1* on PA at *t*. Advantages of multi-level analyses are the possibility to model level 1 error variance and level 2 error variance simultaneously and to handle different numbers of observations for each participant. We included PA at *t* as dependent variable and positive events at *t-1* as random independent variable. We built four different models with (1) no covariates (model 1), (2) only PA at *t-1* as covariate (model 2), (3) only positive events at *t* as covariate (model 3), and

(4) both PA at *t-1* and positive events at *t* as covariates (model 4). This enabled the inspection of unique effects of positive events at *t-1* on PA at *t* while adjusting for the autocorrelation of PA (model 2 and 4) and/or for the positive events that occurred in between (model 3 and 4). Only model 4 reveals unique effects of positive events at *t-1* on PA at *t* by adjusting for concurrent positive events and PA. We examined whether the effect of positive events at *t-1* on PA at *t* (i.e. within-subject effect) was moderated by neuroticism or extraversion by testing the cross-level interaction between positive events at *t-1* and neuroticism or extraversion. We used standardized scores for neuroticism and extraversion and person-specific mean centered scores for the within-subject predictors. Note that the positive events at *t-1* reflect the valence of the most important event that had happened in the period between *t-2* and *t-1*.

All analyses were performed in Mplus (Muthen & Muthen, 1998-2010) with maximum likelihood estimation with standard errors robust to non-normality. Significance levels (two-tailed) were set at $p < .05$ for all analyses.

Results

Descriptive statistics

The mean number of completed responses of the included participants was 64.93 (92.8% compliance rate, *SD*: 3.41) in Study 1 and 42.45 (78.6% compliance rate, *SD*: 6.73) in Study 2. The final data set of Study 1 consisted of 3503 momentary measurements (level 1) provided by 70 female young adults (level 2), and the final data set of Study 2 consisted of 4606 momentary measurements (level 1) provided by 141 female adolescents (level 2).

Descriptive statistics and Pearson product moment correlations between neuroticism, extraversion, mean PA and mean positive events are depicted in Table 7.1. In both studies, we found a negative relation between neuroticism and the mean of PA, whereas the relation between extraversion and mean PA was positive.

Influence of Neuroticism and Extraversion on the prolonged effect of positive events

The results of the multilevel analyses with neuroticism and extraversion as moderators of the prolonged effect of positive events at *t-1* on PA at *t* are presented in Table 7.2 and 7.3, respectively. In both studies, positive events at *t-1* significantly predicted PA at *t* in

models 1, 2 and 3. The effect of positive events at *t-1* on PA at *t* was no longer significant in model 4, in which positive events at *t* and PA at *t-1* were simultaneously included as covariates.

Table 7.1: Descriptive statistics of the study variables and Pearson correlations

Study 1: female young adults (18-25 years)							
Variable	***Mean***	***SD***	***Minimum***	***Maximum***	***1.***	***2.***	***3.***
1. Mean Pos. event[a]	1.17	0.36	0.31	2.42	-		
2. Mean PA[b]	4.65	0.63	3.02	5.96	.43***	-	
3. Neuroticism[c]	4.65	2.73	0.00	12.00	-.12	-.48***	-
4. Extraversion[d]	169.36	18.59	128.00	217.00	.15	.31*	-.27*
Study 2: female adolescents (13-16 years)							
Variable	***Mean***	***SD***	***Minimum***	***Maximum***	***1.***	***2.***	***3.***
1. Mean Pos. event[a]	1.45	0.45	0.52	2.55	-		
2. Mean PA[b]	5.08	0.69	3.18	6.49	.30***	-	
3. Neuroticism[c]	5.09	2.66	0.00	12.00	-.02	-.26**	-
4. Extraversion[d]	9.36	2.35	0.00	12.00	.18*	.29**	-.24**

Note. PA = positive affect
[a]Mean of pleasantness of most important event, calculated across all time points (range 0-3), [b]Mean of PA, calculated across all time points, [c]Sum score of neuroticism scale of EPQ-RSS, [d]Sum score of extraversion scale of NEO-PI-R, [e]Sum score of neuroticism/ extraversion scale of JEPQR-S
*$p < .05$, **$p < .01$, ***$p < .001$.

In Study 1, we found a small negative influence of neuroticism on the effect of positive events at *t-1* on PA at *t*, but only when we adjusted for positive events at *t* and PA at *t-1* (model 4); individuals higher in neuroticism reported less PA at time *t* after a positive event at *t-1* than individuals lower in neuroticism. This interaction effect was not replicated in Study 2. In Study 1, we also found a small positive influence of extraversion on the effect of positive events at *t-1* on PA at *t*, but only when the effect was adjusted for PA at *t-1* (model 3); individuals higher in extraversion reported more

Table 7.2: Multilevel model to examine the influence of neuroticism on the prolonged effect of positive event score t-1 on PA t

Study 1: female young adults (18-25 years)	*Model 1[a]*	*Model 2[b]*	*Model 3[c]*	*Model 4[d]*
Variable	***B (SE)***	***B (SE)***	***B (SE)***	***B (SE)***
Intercept	4.66 (0.06)***	4.68 (0.06)***	4.66 (0.06)***	4.68 (0.06)***
Pos. event *t-1*	0.14 (0.02)***	0.06 (0.02)**	0.04 (0.02)*	-0.02 (0.02)
PA *t-1*			0.29 (0.03)***	0.23 (0.03)***
Pos. events *t*		0.36 (0.02)***		0.33 (0.02)***
Neuroticism	-0.30 (0.07)***	-0.30 (0.07)***	-0.30 (0.07)***	-0.30 (0.07)***
Pos. event *t-1* x Neuroticism	0.00 (0.02)	-0.02 (0.02)	-0.02 (0.01)	-0.03 (0.01)*
Study 2: female adolescents (13-16 years)	*Model 1[a]*	*Model 2[b]*	*Model 3[c]*	*Model 4[d]*
Variable	***B (SE)***	***B (SE)***	***B (SE)***	***B (SE)***
Intercept	5.09 (0.06)***	5.08 (0.06)***	5.09 (0.06)***	5.08 (0.06)***
Pos. event *t-1*	0.06 (0.01)***	0.04 (0.01)***	0.03 (0.01)**	0.02 (0.01)
PA *t-1*			0.24 (0.02)***	0.23 (0.02)***
Pos. events *t*		0.12 (0.01)***		0.11 (0.01)***
Neuroticism	-0.18 (0.06)**	-0.18 (0.06)**	-0.18 (0.06)**	-0.18 (0.06)**
Pos. event *t-1* x Neuroticism	0.01 (0.01)	0.01 (0.01)	0.00 (0.01)	0.00 (0.01)

Note. Pos. event = pleasantness of most important event (range: 0-3), PA = positive affect [a]Model 1: without covariates, [b]Model 2: correcting for pos. events *t*, [c]Model 3: correcting for PA_{t-1}, [d]Model 4: correcting for pos. events *t* and PA_{t-1}.
*$p < .05$, **$p < .01$, ***$p < .001$.

PA at time *t* after a positive event at *t-1* than individuals lower in extraversion. In Study 2, we found an opposite effect: individuals lower in extraversion reported more PA at *t* after a positive event at *t-1* than individuals higher in extraversion, but only when we did not adjust for positive events at *t* and PA at *t-1* (model 1). All effects of neuroticism and extraversion were small and only crossed the border of significance in one out of four models in Study 1 or Study 2. Analyses including neuroticism and extraversion simultaneously in one model resulted in similar coefficients (results are available on

Table 7.3: Multilevel model to examine the influence of extraversion on the prolonged effect of positive event score t-1 on PA t

Study 1: female young adults (18-25 years)	*Model 1[a]*	*Model 2[b]*	*Model 3[c]*	*Model 4[d]*
Variable	***B (SE)***	***B (SE)***	***B (SE)***	***B (SE)***
Intercept	4.66 (0.07)***	4.68 (0.07)***	4.66 (0.07)***	4.68 (0.07)***
Pos. event *t-1*	0.14 (0.02)***	0.06 (0.02)**	0.04 (0.02)*	-0.02 (0.02)
PA *t-1*			0.29 (0.03)***	0.23 (0.03)***
Pos. events *t*		0.36 (0.02)***		0.33 (0.02)***
Extraversion	0.19 (0.06)**	0.19 (0.06)**	0.19 (0.06)**	0.19 (0.06)**
Pos. event *t-1* x Extraversion	0.02 (0.02)	0.01 (0.02)	0.03 (0.01)*	0.02 (0.01)
Study 2: female adolescents (13-16 years)	*Model 1[a]*	*Model 2[b]*	*Model 3[c]*	*Model 4[d]*
Variable	***B (SE)***	***B (SE)***	***B (SE)***	***B (SE)***
Intercept	5.08 (0.06)***	5.08 (0.06)***	5.08 (0.06)***	5.08 (0.06)***
Pos. event *t-1*	0.06 (0.01)***	0.05 (0.01)***	0.03 (0.01)**	0.02 (0.01)
PA *t-1*			0.24 (0.02)***	0.23 (0.02)***
Pos. events *t*		0.12 (0.01)***		0.11 (0.01)***
Extraversion	0.20 (0.05)***	0.20 (0.05)***	0.20 (0.05)***	0.20 (0.05)***
Pos. event *t-1* x Extraversion	-0.02 (0.01)*	-0.02 (0.01)	-0.02 (0.01)	-0.01 (0.01)

Note. Pos. event = pleasantness of most important event (range: 0-3), PA = positive affect [a]Model 1: without covariates, [b]Model 2: correcting for pos. events *t*, [c]Model 3: correcting for PA_{t-1}, [d]Model 4: correcting for pos. events *t* and PA_{t-1}.
*$p < .05$, **$p < .01$, ***$p < .001$.

request). Adjusted for each other, neuroticism and extraversion did not significantly influence the effect of positive events at *t-1* on PA at *t*, except for extraversion in model 1 in Study 2.

Post-hoc analyses

Our findings that neuroticism and extraversion did not consistently moderate prolonged effects of positive events on PA, prompted the question whether neuroticism and extraversion did moderate the effects of positive events on PA in the short run. Therefore, we performed additional multi-level analyses to examine whether neuroticism and extraversion moderated the direct effect of positive events at *t* on PA at *t*. Adjusted for PA at *t-1*, that is PA before the positive event happened, neuroticism and extraversion did not significantly influence the effect of positive events at *t* on PA at *t* in either study (Neuroticism x Pos. event *t*: Study 1: $B = 0.04$, $SE = 0.02$, $p = 0.112$; Study 2: $B = 0.01$, $SE = 0.01$, $p = 0.225$; Extraversion x Pos. event *t*: Study 1: $B = -0.02$, $SE = 0.02$, $p = 0.469$; Study 2: $B = -0.02$, $SE = 0.01$, $p = 0.107$).

Discussion

The aim of this study was to investigate whether neuroticism and extraversion moderated the prolonged effect of positive events on PA in daily life. For this purpose we used two independent samples. In line with previous ESM studies (e.g. Carstensen et al., 2000; Longua et al., 2009; Zautra et al., 2005), we consistently found that neuroticism was negatively, and extraversion was positively associated with average levels of PA. We also found some small moderating effects of neuroticism and extraversion on the prolonged effect of positive events on PA, but these effects were only significant in one out of four models and were not consistent across the two studies. Thus, neuroticism and extraversion were not robustly associated with the extent to which a person benefitted from positive events over an extended period.

Our results are in accordance with studies by Verduyn and colleagues (2009; 2012), who did not find robust effects of neuroticism and extraversion on the duration of PA either. To our knowledge, the studies by Verduyn and colleagues (2009; 2012) are the only ones that investigated the duration of PA after the occurrence of an event in daily life. As mentioned in the introduction, these studies were limited in that participants

reported the duration of affect retrospectively at the end of the day. Memory biases might have influenced the results, because affect influences the way in which people experience time (e.g. Droit-Volet & Meck, 2007; Frederickx et al., 2013). However, we found similar results using a more objective but indirect measure of the influence of neuroticism and extraversion on the duration of PA (i.e. the extent to which positive events influence PA over an extended period of time, both unadjusted and adjusted for concurrent positive events and PA). Thus, taken together, neuroticism and extraversion do not seem to influence prolonged effects of positive events on PA.

Alternatively, the absence of moderation of neuroticism and extraversion in our study could be related to the time span between consecutive measurements, which covered 30-480 minutes. It is possible that neuroticism and extraversion only influence the effects of positive events on PA in the short run, and that our time span was not suitable to reveal these effects. Post-hoc analyses, however, render this explanation unlikely; neuroticism and extraversion did not moderate effects of positive events on PA in the short run (i.e. 0 to 240 minutes later) either. Moreover, previous studies using a short time period also did not find convincing evidence that neuroticism and extraversion modified the duration of PA after positive events (Hemenover, 2003; Schimmack, 2003). In sum, the current state of knowledge indicates that neuroticism and extraversion do not moderate effects of positive events on PA in the short nor long-run.

The lack of moderation of the prolonged effect of PA by neuroticism and extraversion seems to be in disagreement with findings that savoring is differentially related to neuroticism and extraversion (Bryant, 2003; Livingstone & Srivastava, 2012; Wood et al., 2003). Savoring relates to cognitive or behavioral strategies that regulate the intensity or duration of PA in reaction to positive events (Bryant, 2003). Some strategies are applied before positive events even occur (i.e. savoring through anticipation), others while positive events are happening (i.e. savoring in the moment), or after positive events, that is savoring through reminiscence (Bryant, 2003). Neuroticism and extraversion have been shown to be related to beliefs about the use of these three savoring components (Bryant, 2003). Dampening, a strategy that curtails PA, has been positively associated with neuroticism (Ng, 2012; Wood et al., 2003). Hence, based on these studies, one would expect that event-related PA would have a longer duration in individuals high in extraversion and a shorter duration in individuals high in neuroticism, but this was not the case in our samples. There might be a discrepancy between beliefs about the use of

savoring or dampening strategies and their actual use in daily life.

In our study, we used an event measure that was a mixture of different types of events. Possibly, neuroticism and extraversion are only related to the duration of PA after the occurrence of specific events. The study of Wood et al. (2003) indicated, for example, that neuroticism was only associated with dampening strategies after a self-relevant event (i.e. personal success) and not after a non-self-relevant event (i.e. survival of a friend). Future studies would benefit from investigating personality differences in prolonged effects of specific positive events on positive affect.

This study focused solely on PA. In theory, it would have been interesting to examine whether neuroticism and extraversion are associated with the prolonged effect of events on negative affect. However, in practice, the presence of floor effects in negative affect in both samples hindered this. In non-clinical samples, the means and standard deviations of negative affect are typically low (e.g. Bylsma et al., 2011; Jacobs et al., 2011; Thompson et al., 2012), which indicates little room for a decrease in negative affect. This reduces the possibility to change and introduces a potential source of bias. This is an underestimated problem that should receive more attention. Floor effects are of a substantive rather than methodological nature, and need careful consideration.

One of the major strengths of our study is that we used two independent studies, and a strong methodology (i.e. Experience Sampling). Hence, we were able to examine the influence of neuroticism and extraversion on prolonged effects of positive events on PA in an ecologically valid way, without having to rely on participants' memory recollection over lengthy periods of time, and to investigate the robustness of these effects in a field characterized by inconsistent findings.

Our study also has some limitations that have to be taken into account when interpreting our findings. First, we investigated our research questions in healthy females aged between 13 and 25 years. Further research is required to investigate whether our results generalize to males, individuals older than 25 years of age and clinical populations. Second, although we made a selection of measurements to make the time intervals between measurements more comparable, the time between two consecutive measurements still varied. These time differences between two consecutive measurements together with the lack of information about the exact times when positive events occurred, resulted in a mixture of different time spans on which the prolonged effects of positive events on PA were calculated, ranging from 151 to 420

minutes in Study 1 and from 31 to 480 minutes in Study 2. These varying time spans may have affected the size of the effects conservatively, but probably not to a great extent, because we found similar effect sizes in Study 1 and 2, whereas the time span was larger in Study 2. We think that the benefits of a daily life measure, including strong ecological validity without heavily relying on the memory of participants, outweigh the restrictions. Nonetheless, more fine-grained examination of the duration of PA in daily life is preferable in future research. Third, we measured positive events with the question how (un)pleasant the most important event was, and recoded negative event scores into 0, resulting in a range of 0 to +3. This could be optimized by using separate measures for the most important pleasant and unpleasant event with a wider range. This way, it would be possible to control for each other.

To conclude, this Experience Sampling study in two independent samples of early adolescent and young adult females revealed a negative relation between neuroticism and mean PA, and a positive relation between extraversion and mean PA. Although previous studies suggest that individuals higher in neuroticism or lower in extraversion are unable to sustain heightened PA after positive events, because these individuals reported the use emotion regulation strategies that dampen PA more often and strategies that savor PA less often, we did not find robust evidence that neuroticism and extraversion were related to prolonged effects of positive events on PA.